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ABSTRACT

This paper presents a generalized solution to the problems that people with disabilities face regarding accessing the Internet. Of particular interest is the way in which the authors' paradigm allows for enhanced interaction with information resources, including distance learning and education in general. A basic overview is provided of the authors' approach to serving the World Wide Web accessibility needs of the disabled community. The focus of the project consisted of developing an Internet site that functions as a central location for computer resources targeted at the disabled. In addition to the Web site, a number of specific interface modules have been developed, including several virtual keyboards, a voice controlled mouse, an acoustic output mouse, a joystick-based mouse, and other acoustic navigation tools. An example of the of the unique features of the disability resource Web site is presented--a customizable lightweight voice recognition/PC control module for speech impaired users. Four figures illustrate: using the Web to provide access to the world; discrete non-verbal utterance recognition process flow-chart; a typical "D" sound; and the frequency power spectrum of the "D" sound. A table contains a sample identification of the female vocalization of "D." (Author/DLS)

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The Internet and Its Importance for Those with Disabilities: An Example

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Abstract: This paper presents a generalized solution to the problems associated with accessing the Internet by people with disabilities. Of particular interest is the way in which the authors' paradigm [1] allows for enhanced interaction with information resources, which we take to include distance learning and education in general. We provide here a basic overview of our approach to serving the WEB accessibility needs of the disabled community. In addition, we present as an example of the unique features of our disability resource web site, a customizable lightweight voice recognition / PC control module for speech impaired users.

Introduction

For many years people in the technology area, specifically engineering, have attempted in a variety of ways to make the lives of those with various disabilities easier and to give them access to the wider variety of activities and facilities that most of us take for granted [2-5]. Depending on the nature and severity of their disabilities, these people may have communication problems (hearing loss, lack of speech, blindness, et cetera.). In addition, they may have mobility problems that limit their access to telephones, light switches, computer keyboards, et cetera. Physical travel, entrances to shopping malls and libraries remain difficult, if not impossible for some of these individuals. Disabled students face an additional burden if their study materials are not in a form that they can easily work with. Students with sight limitations need tools that can read their books and notes to them and/or enlarge the text to a readable size. Science and math students with sight limitations currently have very few options when it comes to reading complex math equations. Individuals with speech and/or mobility problems experience a different set of challenges. But in each case, we believe enhanced access to a computer (and hence the vast resources available through the computer and the World Wide Web) is possible. When one attempts to do something in this realm one has to be intimately aware of the fact that the over all impact will be minor. Never the less, the endeavor is worthwhile, since the impact on the targeted subset of the disabled community may be quite significant especially where improving education is the goal.

Educators, family members and special assistants face their own set of challenges when working with disabled students. They need to prepare both a special environment and class material in a form accessible to each disabled student. In addition, they need to evaluate the performance of the student. Many times, the disabled student will have trouble taking tests in the standard time. Allowing extra time helps with part of the problem. But if an assistant is required to help the student with taking the test, it can be hard for the instructor to assay the difference between what the student understands and what the assistant inadvertently added. Most of these problems imply greatly increased effort and expense on the part of the facilitator. A properly configured WEB solution can alleviate many of these difficulties [6].

Basic Problem

The convergence of cheap miniaturized computers with the evolution of many other technical innovations has finally become focused to the point where a realizable impact can be made in the many areas just described. One might speculate that much of what is happening today in the United States is the result of recent U.S. legislation, in particular, the Americans with Disabilities Act of 1990 (ADA) [7]. Many of the products and capabilities now being developed may well

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have occurred without this impetuous. But the publicity and media focus [8] on disability generated by this Act has enabled much of this effort to become public where as in the past, it might not have been.

A problem with many currently available assist devices is that they tend to be quite expensive and they only work with a very narrow range of disabilities. Many times, more than one special device or software package is required to meet the needs of the given individual. What will work for one will not work for another. It has also been found that separate packages/devices don't work well together. Thus educators and families face a difficult problem in selecting and configuring a PC to deal with their child's/student's problems. These solutions also become obsolete in a few years as the child grows up and their needs change and as technology advances. Lastly, these solutions deal with only a portion of the problem; namely the human to computer interface (HCI). They do not address human to world interface issues at all.

Consider for a moment the individual who has very poor eyesight and can only read large letters. This might include the inability to focus on a single letter or worse yet, to see multiple overlapping images. Consider further an individual with cerebral palsy in conjunction with a vision problem. Thus, there is a very limited ability to input information into a computer in the same way or with the same dexterity that a non-disabled person would have. How does one go about helping this person?

A Solution

Clearly what is needed is an inexpensive, yet comprehensive system that works on the wider range of computing platforms and which can adapt both to changes in the student's needs and to advances in the underlying hardware and software. The Internet provides an excellent starting point for such efforts. It works seamlessly over a wider range of platforms, gives access to the World Wide Web (WEB) and is essentially free. Through the Internet and the WEB in particular, a wealth of documents, search tools, news, special interest sites, shopping opportunities, travel information and booking services as well as resources for education can be made available. Teachers are now beginning to put full-blown courses on the network along with live sound video, problem solutions and interactive sessions. In a sense, the Internet can serve as the human to world interface. It can be easily extended via a local web site to allow access to scan textbooks etc. Many educators deem this interaction, which may be limited for disabled students, essential.

Because users with special needs do not fit standard interfaces, there needs to be an intermediate interface or adaptation that acts as a "prostheses" to make the original interface accessible to users with disabilities. If the adaptation is well suited to the user's requirements, it provides a better interface to the application. Much thought has gone into the development and implementation of these adaptations and intermediate interfaces [1-6]. For the past two years, the above investigators have been working to develop a general solution to the many problems that students with disabilities experience as they try to obtain an education at the University/College level. We have developed a paradigm that should prove effective for this class of students and which can provide a framework for solving many of the difficulties that presently are encountered. We believe that the solution that we have put forward will resolve one of the most serious problems in this area. Namely that each student with a disability is unique, and requires a unique solution to his/her specific set of disabilities.

The thrust of the project consisted of developing an Internet site that functions as a central location for computer resources targeted at the disabled. The site acts as an easy way to distribute new software that has been developed, as an online collection of documentation related to disabilities, as a pointer to other Internet sites containing relevant information and as an interactive tool for distance learning. Most importantly, since the people with disabilities will presumably be the primary users, the web site was built with them in mind and it is customizable to accommodate their disabilities.

When a user first accesses the site, he or she will be offered a chance to work with an online configuration wizard. The answers that they provide to the wizard will allow the site to dynamically alter its appearance and will pre-select the subset of software modules that will most likely be of interest to this user. The user can play with and pre-configure many of these modules prior to adding them to their local system. The ability to track users and maintain a profile of their unique preferences is built into the site through the use of a database. The idea of centering the site around the needs of the disabled is continued by allowing users to add links to external Internet sites as well as to receive updates by e-mail of when the site has been updated. The included built-in search engine facilitates finding specific software modules and information.

From a site administrators view point, incorporating additional software components is as simple as filling out a form and

copying the necessary files to the server. The framework for future growth of the site has been established. Because the site is simple to use and interact with the user, the likelihood of a user returning is greatly improved.
As a general solution, it is an inexpensive, comprehensive system which works on a wide range of computing platforms and can adapt both to changes in the disabled individual needs and to advances in the underlying hardware and software technologies. This system functions to more fully integrate the person with the rest of the world without the addition of extensive additional human assistance. This concept is shown more clearly in Figure 1.

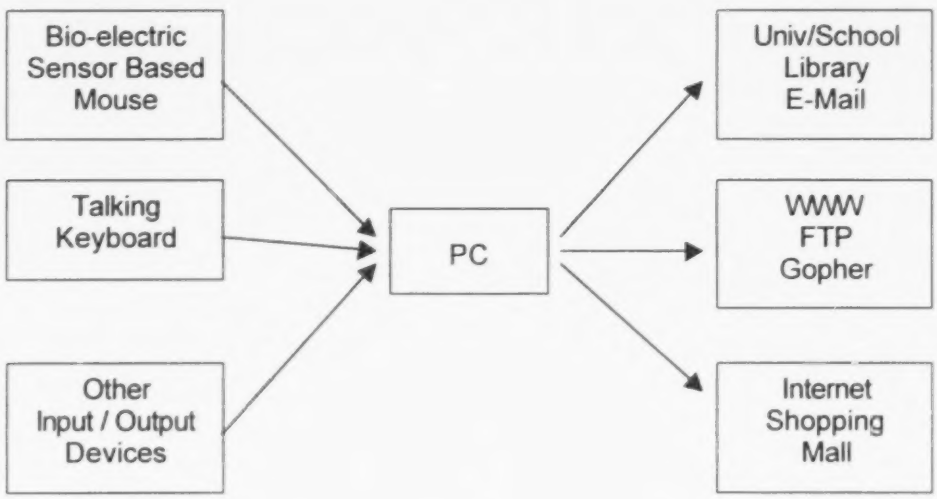

Figure 1: Using the World Wide Web to provide access to the world.

In addition to the web site, a number of specific interface modules have been developed. These include several virtual keyboards, a voice controlled mouse, an acoustic output mouse, a joystick based mouse, and a variety of other acoustic PC navigation tools.

Example: Speech Control of the Computer

One module currently under development is a lightweight non-verbal recognition engine that can map reproducible utterances to specific PC control functions. Our initial application was the implementation of a voice-activated mouse (VAM). The VAM is a complex module, which requires training before it can be used. A setup wizard walks the user through a series of steps which gives the user vocal control the mouse on the screen.

Such a system is implemented through an Automated Sound Recognition System (ASR). There are a variety of techniques available that do voice-to-text fairly well. These are incorporated in many of the commercial products available, such as IBM's "Via Voice Gold" and Dragon System Inc.'s "Naturally Speaking" both of which allows for continuous speech recognition and conversion into text. Thus, it is possible to take some individual words and convert them into symbols, which ultimately can control the movement of the mouse. Coupled with this idea, is the possibility that some individuals might not be able to speak clearly and distinctly. The commercial packages listed above can not deal with this scenario. However, if the user can reproduce a small set of distinct sounds with some fidelity then these sounds can be mapped to control functions. Clearly, the larger the set of distinct utterances, the easier it will be to control the multitude of PC / browser functions. However, this technique can work with as few as one reproducible utterance.

Our example is very simple in as much as we chose to use the four letters L (left), R (right), U (up) and D (down), respectively to develop the concept. Any substitute for a clearly spoken articulation of these letters would be equally acceptable. Required are the use of an FFT algorithm and the development of a simple template for each letter (word). The process is simple in concept. A flow chart is given in Figure 2.

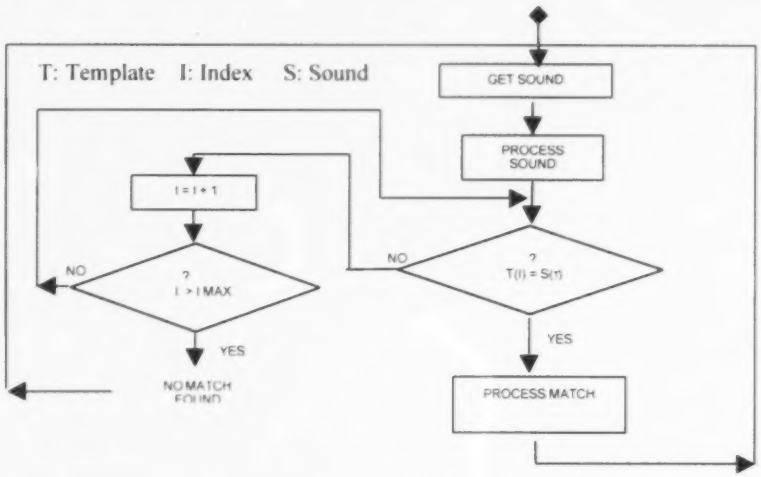

Figure 2: Discrete non-verbal utterance recognition process flowchart.

In our example, the articulation of each sound is first frozen in a window. Then the Fast Fourier Transform (FFT) of the sound is taken to create a template for the four letters. Then when the letters are articulated in a random fashion, the template of the incoming sound is compared to the templates in the system and identified properly in order to move the mouse.

The template was designed by taking the power spectrum of each of the signals and dividing it up into sixteen bins. A single number is produced for each of the sixteen bins by taking the average of the components in each bin. When the sound was articulated, it is processed and its template compared to those already stored. When a good match is found, that particular letter is identified and the appropriate movement of the cursor is initiated. A picture of a typical sound is shown in Figure 3 and its spectrum in Figure 4. For both the calculations of the templates, and the "unknown" test sounds, the average value of each bin is scaled to one hundred. The result of the template-matching procedure for one test sample is shown in Table 1. Several people trained the system and had their templates stored for use when they were active. The miss-identification rate was less than five percent in most cases.

There are certainly a number of issues associated with this particular technique. If a mistake is made, the user will hopefully, if not terribly visually impaired, see that an error has occurred and command the mouse to stop. In addition, the precise motion and control features can be configured on a user by user basis. This is similar to what we do with our other mouse controller modules [1].

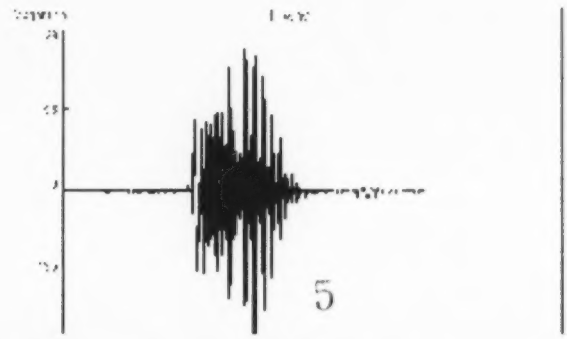

Figure 3: A typical "D" sound.

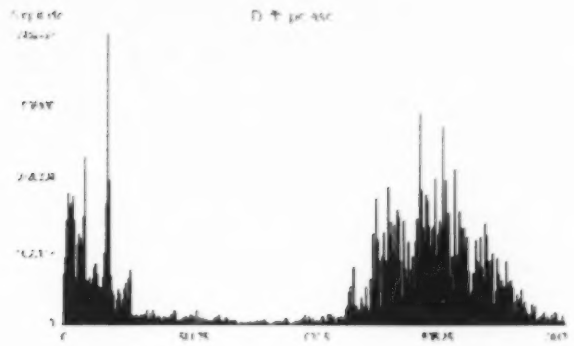

Figure 4: The frequency power spectrum of the "D" sound

Incoming Sound = D5_sound.asc	
	Template Matching Error
D	**0.29**
L	4.29
R	5.2
U	1.65
Sound identified as a "D"	

Table 1: Sample identification of female vocalization of "D".

Software

The question of software appropriate to such a project is always important, particularly in view of the fact that software is constantly changing and what might be appropriate today, might not be appropriate in another year. We have tried our best to avoid this problem by using software that has proven its worth over an extended period of time. Much of the software is available through Microsoft. The site itself makes extensive use of Microsoft's Active Server Page technologies. Many of

the end user modules have been written in Visual Basic as ActiveX controls. In the future, we plan to move portions of code base over to Dynamic HTML (DHTML). This will provide improved platform independence as well as performance enhancements.

Conclusions

The exercise reported here has demonstrated clearly that the development of the web site for the disabled is both possible and necessary. While only the voice activated mouse is reported here, there are a number of other modules, which we have developed to handle other kinds of disabilities. These can be simply adapted to individual needs, but more to the point, a variety of these can be developed, a subset of which will be applicable to most individuals whose disabilities are severe. Each case is unique and will have to be examined individually. At this particular time, the web site provides access to all other webs in the system and also provides a very simple search engine. In addition, the web site also stores information for various users once they register and keep track of the modules, which they desire to use and save. This information can individualize the module when certain things must be learned for specific individuals. In the voice activated mouse system, templates would be customized for each individual user, so when they return at a later date, development will not have to be repeated. Readers are encouraged to look at the web site that has been created at http://www.nd.edu/-vx.

References

1 P. D. Beery and J. Uhran, Jr., "*The Impact of Technology upon Educating the Physically Disabled*", Proc. of the International Conference on Computers and Their Applications, Phoenix, AZ, March, 1997.

2 Craig and P. McIssac, "*Mind Switch*", University of Technology, Sydney, Australia, http://www.phys.uts.edu.au/~asearle

3 J. Gips, "*Toward an Intelligent Interface for EagleEyes*", Proc. AAAI Symposium on Developing Assistive Technologies for People with Disabilities, MIT, Nov. 1996.

4 "*Closing The Gap: Microcomputer Technology in Special Education and Rehabilitation*", "Closing The Gap" Conference, Minneapolis, Fall 1996

5 H.S. Lusted and R.B. Knapp, "*Controlling Computers with Neural Signals*", Scientific American, Oct. 1996, pp82-87.

6 P. D. Beery and J. Uhran, Jr., "*A General WEB Based Accessibility Solution For Individuals with Disabilities*", ICEE'97 Conference --International Conference on Engineering Education, Chicago IL, August 1997

7 *Americans with Disabilities Act of 1990*, http://www.usdoj.gov/crt/ada/pubs/ada.txt

8 *Americans with Disabilities Act Document Center* (http://janweb.icdi.wvu.edu/kinder), rated by Point Cast as among the top 5% of all sites on the Internet, September 1996